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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project	Date	Author

TITLE

EXPERIMENTAL BARK BEETLE CONTROL PROJECT
COEUR D'ALENE NATIONAL FOREST
SPRING 1941

PENETRATING SPRAYS

by
James C. Evenden
Senior Entomologist

Forest Insect Laboratory
Coeur d'Alene, Idaho
September 26, 1941

SUBJECT—

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BEAU OF
Entomology and Plant Quarantine
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PORTLAND, OREGON

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Noted by JAM

For information of Mr. Burnside FTR

RLF

WDR

WJB

October 14, 1941

To: Regional Forester, Missoula, Montana
Attention of Mr. Koch

From: James C. Evenden, Box 630, Coeur d'Alene, Idaho

Subject: Penetrating Sprays - Coeur d'Alene National Forest
Experimental Project

I wish to thank you for your comments and kind statements concerning our report of the Coeur d'Alene experimental control project. In answer to your question, the total cost of the project does not include the salary overhead of Nelson, Gibson, and Terrell. Perhaps the salary of Terrell should have been included in this cost, for he devoted his entire time to the training and supervision of the treating crews. Gibson spent most of his field time in conducting experimental tests of other formulas, so his salary would not be a legitimate charge. As to Mr. Nelson's salary, I do not know what your ruling would be in regard to this contributed overhead and supervision.

We recognize of course that the term "noneffective man-days" is somewhat misleading, for there are certain of these duties that are essential for all projects. Perhaps a better expression would be "nonproductive time", with a breakdown of this into effective and noneffective. Although, as you state, one is immediately struck by the ratio of 517 nonproductive man-days to 592 man-days of spotting and treating, I do not see how the project could have been organized so as to have reduced this percentage. The only actual loss to the project was the time of the few monthly men during rainy days, which of course can not be remedied. Due to all factors encountered during this project the organization and administration of the project must be considered as satisfactory in every detail.

As to your statement concerning the possibility of penetrating sprays reducing the cost of other previously used methods, I hesitate to make a definite statement. Mr. Nelson and I have just discussed this question and we both feel that due to labor and weather conditions encountered during this spring's operation the peeling or the decking and burning of these trees would have been as much, if not more, than the cost of spraying. However, this is a debatable question and one

that can only be solved by additional projects. The cost of transportation would be materially reduced if our camp had been serviced by trucks, as is the case with most projects at this time. It is also possible that cheaper formulas may be developed, and I also believe that with additional experience and training the output per man-day can be increased. Although the cost may not be materially reduced, it does eliminate the use of fire, which is a worth while consideration.

I again wish to thank you for your kindness in connection with this project and for your interest shown in relation to our report.

Copies of this memo are being sent to the Supervisor of the Coeur d'Alene National Forest, to Dr. F. C. Craighead at Washington, and to R. L. Furniss of our Portland office.

James C. Evenden
J. E.

BUREAU OF
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PORTLAND, OREGON

File No. ....
Noted by .... TJK
RLF
WBB
WJB

October 2, 1941

To: Dr. F. C. Craighead, in Charge, Forest Insect Investigations

From: James C. Evenden, Box 630, Coeur d'Alene, Idaho

Subject: Experimental Bark Beetle Control Project, Coeur d'Alene National Forest, Spring 1941

I am enclosing two copies of our report on the experimental bark beetle control project conducted on the Coeur d'Alene National Forest in the spring of 1941. As I re-read this report it seems that there is considerable information which might have been omitted. However, it was included with the idea of making available all known information that might be useful in planning for subsequent projects.

You will note that we estimate a brood mortality of 91.3%, which I feel is quite conservative. However, in view of the conditions peculiar to this project I believe that figure should be accepted as being satisfactory. In subsequent projects I am quite sure that the output per man-day could be increased and a more thorough job of treatment performed, which would not only lower the cost per tree but would show a higher degree of effectiveness.

I would be pleased to have your comments relative to the data shown on page 14 and in table 2 on page 15. These data refer to the decreased effectiveness during the later project periods. I have offered what we believe are the most logical explanations, and would be pleased to have your reaction to this condition.

I had hoped to submit Mr. Gibson's report of his experimental treatments at this time, but as that has not been completed I will not hold this report.

Copies of this letter and the report are being sent to Keen and Miller.

James C. Evenden

Enclosures (2)

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EXPERIMENTAL BARK BEETLE CONTROL PROJECT
COEUR D'ALENE NATIONAL FOREST
SPRING 1941

PENETRATING SPRAYS

by
James C. Evenden
Senior Entomologist

INTRODUCTION

During an actual control project on the Wasatch National Forest in the spring of 1940, penetrating sprays were demonstrated as a practical method of treating lodgepole pine infested with the mountain pine beetle. During the spring of 1941 the United States Forest Service again cooperated with the Bureau of Entomology and Plant Quarantine in making possible a similar project to test the effectiveness of these sprays as a means of control for the same insect in white pine. This project started on the 7th of May and was completed on the 12th of June.

Labor, equipment, supplies, and material were furnished by the Coeur d'Alene National Forest, with Mr. Neal Nelson, Associate Forester, in administrative charge of the operation. Mr. A. L. Gibson and Mr. T. T. Terrell of the Forest Insect Laboratory at Coeur d'Alene, Idaho, were in charge of the technical phases of the field operation. Mr. Gibson checked the effectiveness of the treatment and conducted a number of experimental tests of other spray formulas. Mr. Terrell was responsible for training the treating-crew foremen and the inspection of their work throughout the project. Mr. Fred Birdsell, Forest Service employee, served as camp manager in charge of project administration.

As this project was regarded as an experiment, its different phases have been presented in considerable detail in the hopes that this information will be of service in the planning and administration of subsequent operations.

DESCRIPTION OF PROJECT AREA

The area selected for this experimental control operation is known as the Forks-Cabin and Clay Creek units of the Steamboat drainage of the Coeur d'Alene National Forest. Forest cover is of white pine, approximately 120 years of age, with grand fir, hemlock, and Douglas fir growing in mixture. Although insects have been responsible for severe losses of white pine, there is still a good stocking, which will perhaps average from 20,000 to 22,000 B. F. per acre. The terrain is rough, with the steep slopes broken by some rock slides and outcroppings, and where the canopy has been opened by past insect kills rather dense underbrush occurs. The camp was located in the center of the project area at the mouth of Cabin Creek, and was approximately two and one-half miles by pack trail from the end of truck transportation on the Steamboat Creek road.

GENERAL PLAN OF ADMINISTRATION

This project was organized on the same basis as past white pine control operations, with the exception that the treating crew organization was adapted to meet the requirements of the penetrating-spray method of treatment.

Supervision

All administrative phases of the project were under the direction of the Forest Service, with Mr. Birdsell acting as camp manager under the direction of Mr. Neal Nelson of the Coeur d'Alene National Forest. Messrs. Terrell and Gibson of the Bureau of Entomology and Plant Quarantine assumed responsibility for all technical phases such as the trees to be marked for treatment, areas to be spotted, and the method of treatment. Although the duties of all these men were quite distinct, very close cooperation existed, with all men in supervisory positions extending every effort to make the project a success.

Spotting

Two regular spotting crews of six men each were employed.

Treating Crews

Eight crews of three men each were used in treating the infested trees. These crews consisted of a leader and two laborers, with each crew functioning as an independent unit. One pack mule was assigned to each crew for the transportation of spray from the camp to the woods.

Service of Supply

Camp equipment and subsistence supplies were transported in trucks to the end of the Steamboat Creek road and then by pack mules to the camp. Spray materials (fuel oil and orthodichlorobenzene) were received at the end of truck transportation in 50-gallon drums. The spray was mixed at this point, transferred to 5-gallon containers, and packed in specially constructed pack boxes to the camp, where it

was again stored in 50-gallon drums or taken directly to the treating crews. Each pack animal carried 20 gallons of spray.

Spray Formula Used

Orthodichlorobenzene	1 part by volume
Fuel oil	4 parts by volume

To avoid the possibility of error the two ingredients used in this formula were mixed under the direct supervision of Mr. A. L. Gibson. In addition to this formula both controlled and practical tests were made of other combinations of these ingredients to determine if smaller amounts of orthodichlorobenzene would be equally effective.

Equipment

Smith Banner, 4-gallon, compressed-air sprayers were used to apply the spray. These sprayers were equipped with one 24-inch extension rod, a swivel joint, and a specially prepared nozzle designed to throw a flat fan-shaped spray so as to provide a thorough coverage with a once-over movement.

This equipment was satisfactory, although the hose which comes as standard equipment on the sprayers is not oil resistant, making an early replacement necessary. Fortunately this condition had been foreseen and oil-resistant hose ("Mainstay", D. B. Smith Co.) and extra gaskets ("Thiokol", D. B. Smith Co.) were available for replacements when needed. More work is necessary to make the special nozzle more durable and to provide a more uniform flow of liquid in all portions of the fan-shaped spray. As the bore of this nozzle is of necessity quite small, it is easily plugged with any foreign substance that gets into the spray as it is handled or through the decomposition of the

nonresistant hose. Although strainer funnels were used in an attempt to keep the spray clean, considerable inconvenience was experienced. Late in the project a strainer, which is used at the base of the extension rod, was obtained and found to be quite effective in eliminating this inconvenience.

Two types of 5-gallon containers - black-enameled honey cans and aluminum-painted alcohol cans - were used in transporting the spray to the treating crews. Although this equipment was satisfactory, the alcohol can seemed most desirable, as it was equipped with a larger wooden handle, making it easier to carry; a collapsible spout; and the paint was apparently resistant to the corrosive effects of the spray mixture. Both cans were equipped with non-leak pressure caps. In using these cans the light tin retaining rings should always be used, as the caps can be quite easily knocked loose by limbs or other objects. Two pack animals received oil burns when the caps were knocked loose.

The two-compartment pack boxes proved satisfactory and withstood the rough treatment they received. As these boxes were packed vertically instead of horizontally as previously used, they should be constructed with straps for fastening to the pack saddles, which would be an advantage over the sling ropes now used.

WEATHER CONDITIONS

As this project was instituted under the assumed premise that both temperature and precipitation were factors which would influence the effectiveness of the spray, weather records were maintained at the camp during the control operation as well as the subsequent periods of

examinations. Adverse weather conditions prevailed throughout most of the project period. As the work was disrupted by severe rainstorms, the lost time resulted in a marked turnover of labor. Of the six treating crew foremen trained at the start of the project, only two stayed throughout the operation. These frequent changes in overhead required extra training periods and were reflected in the character of work performed. It is believed that the weather conditions to which this project was subjected were as severe as will ever be encountered in future spring operations. At the start of this project rain was viewed with considerable apprehension, and it was planned to suspend treating operations on wet days; however, as so much rain occurred, these plans were changed and the work continued whenever weather conditions would permit the crew to go into the woods.

SPOTTING OPERATION

Two spotting crews were organized under the standard six-man-crew plan, which has been established as the most effective organization in white pine. The compassman extends a line through the area to be spotted, paces the distance traveled and constructs a map showing the location of the trees marked for treatment. The four spotters - two on each side of the compassman - each covers a strip one chain in width parallel to the course of the compassman. The chief spotter works behind his crew where he can properly check the alignment of the spotters and the marking of infested trees.

One of the chief spotters was inexperienced, which influenced the character of his work during the first part of the project. Although the original plan of organization for this project included a

spotter-checker, at the start of the operation no one could be found to fill this position, and at a later date it seemed inadvisable. With non-experimental projects this condition would have been more unfortunate, as spotter-checkers have demonstrated their value in maintaining a high degree of efficiency in spotting organizations.

Due to the experimental character of this project, with primary stress being laid upon the method of treatment, it is quite probable that the supervision of the spotting crews was slighted somewhat. However, the work of these crews was checked as often as possible after the usual training or breaking-in period, and this information indicated that approximately 90 percent of the infested trees had been marked for treatment, which would not be satisfactory under actual control conditions.

TREATING OPERATION

The treating crews were organized on an assumption that the smallest unit that could operate by itself would be the most effective. The three-man crew with one pack animal for the transportation of spray seemed to meet this requirement quite satisfactorily. Although subsequent improvements may be possible, the addition of an extra man did not increase the crew-day output to any great extent and usually resulted in a lower man-day production. However, additional thought should be given to the potentials of treating-crew organization for subsequent projects. In the operation of these crews the two laborers felled the trees and cut the bole sufficiently to permit rolling, with the crew leader doing the actual treating. In treating large logs it was necessary for one

or both of the laborers to assist in turning. Usually the crew leader tended to the pack animal, moving it from place to place as the location of infested trees demanded. Although there were some definite designated duties, the crew was organized with the idea of functioning as a unit, having a task to do, and doing it.

As penetrating sprays are only effective when properly applied, the technique of spraying is vital to the success of the operation. The spray must be applied until the bark glistens and drops of liquid appear on the bark scales. Thick bark requires a heavier treatment, which is accomplished by a second spraying a minute or so after the first coverage has been made. As there is little lateral distribution of the spray, when areas of bark are missed the insects beneath are not destroyed.

When the lay of the log will permit, the treater walks along the top and sprays the upper arc of the circumference. The width of the strip to be covered, which varies with the size of the log, governs the distance that the nozzle is held from the bark. When the top arc has been treated, the log is turned so as to expose another strip. By spraying the top of the log only, penetration is aided by gravity, and the wasting of spray is reduced to a minimum. Although the fan-shaped spray nozzle is designed to provide a thorough coverage with a once-over movement, there must be no unsprayed areas between strips or behind limbs and knots. It is obvious that the wider the arc the slower the treater must move, as the discharge from the nozzle is the same at all times.

STATISTICAL SUMMARY OF PROJECT

This operation was concerned primarily with the practical aspects of a new method of treatment. The primary concern of the experiment rests with the effectiveness of the treatment and cost of the method as compared to those previously used. A comparison of costs is not a simple task, as all projects vary with wage scales, transportation difficulties, and weather conditions. The set-up for this project was perhaps as expensive as any white pine operation will be, with adverse weather conditions, shortage of trained labor, and the necessity for servicing the camp by pack train, materially increasing the total cost per tree. In view of these variable factors it would seem that the fairest comparison would be the output per treating crew man-day.

General Data

Total number of trees treated		1,024
Spray materials used -	gallons	
Orthodichlorobenzene	417	
Fuel oil	1665	
	2082	2,082
Spray material per tree - gallons		2.03
Cost of spray material		
Orthodichlorobenzene - per gallon		$0.764
Fuel oil - " "		0.09
Cost per gallon of spray		0.225
Cost of spray material per tree		0.457

Total expenditures for project		$6,791.35
Available assets		
Orthodichlorobenzene - 575 gal. at $0.764 -	$439.30	
Fuel oil - 350 " " .09	31.50	
Spray pumps $45.44 less 25%	34.08	
Pack boxes $23.01 less 33%	7.66	
5-gal. cans $42.84 less 25%	32.13	
	544.67	544.67
Actual cost of project		$6,246.68
Cost per tree		$6.10

Trees treated per effective man-day - all crews	3.05
No. of man-days treating	336
No. of effective man-days spotting	256
No. of ineffective man-days *	517
Total days available for spotting during project	35
Days when spotting was done	24
Days lost because of rain	9½
Days lost because of Saturday half days	1½
Total days available for treating during project	29½
Days when treating was done	21 **
Lost time due to rain	7
Lost time due to Saturday half days	1½

* Includes man-days for men paid on monthly basis for erecting and dismantling camp, packing, overhead, etc.

** Treating was conducted on rainy days during latter half of project.

Due to adverse weather conditions which prevailed throughout the project, 27.2% of the available spotting time and 23.7% of the treating time was lost because of rain. Obviously this condition disrupted crew organizations, lowered the efficiency of the men, and increased the cost of the project because of the noneffective time of men employed on a monthly basis. Although noneffective time is associated with all projects, on this operation the ratio was decidedly out of proportion. Of the 1109 man-days spent on the project, 517, or 46.7%, were non-effective.

The cost per tree and effective man-day output figure are of interest when compared to data obtained from the control project conducted on the Coeur d'Alene Forest in 1939. *

	Cost per tree	Trees per effective man-day
1939 project (felled and burned)	$5.91	1.56
1941 project (penetrating sprays)	6.10	3.05

These figures are significant in that they show comparable costs, with the later project being conducted under decidedly more expensive and unfavorable working conditions. It is believed that the man-day output for penetrating sprays can be still further increased, which will be reflected in a reduced cost of operation.

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* Unpublished report "Insect Control Report - Fall 1939", by Neal D. Nelson, Associate Pathologist.

Table 1 - Production record of individual crews

Name	Total trees treated	Gallons of spray used per tree	Sq. ft. of bark treated per gallon of spray	Trees treated per effective man-day
Blancher	111	2.36	52.3	3.4
Gumm	208	1.69	104.0	3.4
Kelly	20	1.50	83.7	3.3
Pegg	73	2.14	87.6	3.1
Miller	156	2.27	91.8	2.9
Robinett	60	2.62	97.4	2.9
Reese	125	2.03	106.7	2.9
McKenzie	103	2.09	101.6	2.8
Decker	75	1.56	110.0	2.8
Russell	19	2.80	74.	2.5
Francisco	59	2.28	81.9	2.5

Although the preceding data show wide spread in the output for different crews, these figures do not in all instances depict their actual efficiency. Such factors as distance from camp, nature of terrain, concentration of infestation, size of trees, height of infestation and number of one-sided attacks all influence production. These factors are more pronounced on small projects, where all crews do not have an opportunity to work under average conditions. Discounting somewhat the production record as shown in table 1, it was obvious that as crew leaders gained experience their production increased. The excellent showing by Kelly, who only treated 20 trees, while serving as a foreman

during the last few days of the project, does not discount this observation, as he had gained experience as a laborer throughout the project. Granting that experience is a factor contributing to an increased production, it is also very true that the type of men employed as well as the leadership of the foreman in charge is an important and essential factor.

EFFECTIVENESS OF TREATMENT

Determining the actual brood mortality obtained by penetrating sprays for an experimental project of this size is not a simple task. Sufficient trees must be examined to provide an adequate sample of each crew's work, as well as of the different project periods. As the period of time between treatment and final brood mortality is so varied, it is necessary to reexamine trees showing a high percent of survival to determine subsequent mortalities.

Mortality figures were obtained from counts of living and dead insects made from all portions of each treated tree examined. As the brood were in mature larval, pupal and new adult stages, no question existed as to the cause of mortality. As all living insects were considered as having survived the treatment, and as additional mortality between the time of examination and emergence is quite possible, the data obtained are considered as being conservative. Counts of living and dead insects provided a percentage figure which under the brood conditions of this project gives an acceptably accurate figure as to the spray's effectiveness.

Feeling that weather conditions encountered during different periods of the project, as well as delayed mortality, were factors which would influence results, the project has been divided into three periods, and an average mortality figure computed for each.

First period	May 7 - 19 Average brood mortality	96.6%
Second period	May 20 - 31 Average brood mortality	90.5%
Third period	June 1 - 12 Average brood mortality	84.9%
Average for entire project		91.3%

Although the above figures are considered as providing a sufficiently accurate record of the effectiveness of the treatment, they do not indicate what the surviving portion of the brood actually represents. In answer to this question, Mr. Gibson, who conducted the examinations, sets the surviving brood as being not more than 2 insects per square foot of bark surface.

Examination of treated trees showed two distinct types of brood survival. In most instances living insects occurred in groups or in strip along the axis of the log, while in others as individuals scattered throughout the destroyed portion of the brood. Under the first condition one can assume that the survival resulted from improper treatment rather than from the failure of the spray itself. However, it is more difficult to explain the second condition, which could only have resulted from the ineffectiveness of the spray, which of course could have been an insufficient coverage. It is true that in the base of many trees living insects were found in areas of green bark, where the spray is considered as ineffective.

Brood mortality obtained by the different crews during the three project periods are shown in the following table:

Table 2 - Effectiveness of individual crews during project periods

Treating crew	Period of project when treated: May 7 - 19: No. of trees examined	May 7 - 19: Percent mortality	May 20 - 30: No. of trees examined	May 20 - 30: Percent mortality	June 2 - 12: No. of trees examined	June 2 - 12: Percent mortality	Summary 5/7 - 6/12: Total trees examined	Summary 5/7 - 6/12: Average percent mortality
Russell	10	98.5	*	*	*	*	10	98.5
Robinett	4	96.0	6	98.3	*	*	10	97.7
Blancher	*	*	8	99.4	15	95.1	23	96.6
Miller	8	98.0	3	96.3	11	86.3	22	93.9
McKenzie	*	*	5	97.4	10	88.0	15	91.1
Decker	7	94.6	5	81.0	*	*	12	89.3
Francisco	1	96.0	10	84.5	*	*	11	85.5
Reese	*	*	8	81.0	8	89.9	16	85.4
Gumm	5	97.8	6	93.0	13	78.1	24	85.2
Pegg	*	*	*	*	12	84.8	12	84.8
Kelly			*	*	8	65.6	8	68.1
	35	96.6	51	90.5	77	84.9	163	90.1

* None treated.

The number of trees examined for each crew was based upon the total number treated.

Data obtained from progressive examinations of individual trees provided a slight correction factor which raised the average mortality figure as shown in the preceding tabulation from 90.1% to 91.3%, which is still considered as conservative.

There are a number of plausible explanations for the marked variations in the effectiveness of the different crews, all of which are of

importance. Such factors as volume of spray used, exposure, character of terrain where trees are being treated, underbrush, moss or lichens on the bole, and of course the care of applications are factors which are difficult to evaluate but which influence the effectiveness of the treatment. Most important of all is the manner in which the spray is applied, as in nearly all trees where poor results were obtained, improper or careless treatment seemed to be involved. Considerable areas of bark surface were poorly treated or missed entirely, some logs were not turned, and some entire trees were sprayed too lightly, due perhaps to a shortage of spray. In some instances these omissions were the result of carelessness, while in others they were no doubt due to an improper determination on the part of the crew foremen as to the necessity for further treatment. Regardless of the cause, the poor treatment of a few trees will cause a marked reduction in final figures of effectiveness. No relation could be shown between bark thickness, moisture or texture of the bark, brood density, or tree size, and the effectiveness of the spray.

The reduced effectiveness during the later project periods is difficult to explain. These data seem to upset the previously assumed contention that the lethal effects of the spray were increased by warm weather and retarded by periods of rainfall and their associated lower temperatures. Although no relation could be shown between the results obtained and the weather data for the project, it is recognized that other uncontrolled contributing forces make simple correlations between such factors as precipitation or temperature and the results obtained rather nonsignificant. As a result it is still quite probable that the

previously assumed effects of temperature and precipitation are correct. In considering the potential benefits of warm weather, Mr. Gibson has shown that a greater brood mortality occurred on the tops of logs exposed to sunlight and in open forest exposures, with heavier survival in the shaded portions of the treated trees. Although this fact was quite evident, no correlation could be shown between the time such trees were treated and the occurrence of warm temperatures.

From the data in table 2, one concludes that the length of time between treatment and examination is an important factor. Unfortunately such an explanation is questionable, as some trees treated during the first period showed a satisfactory mortality a few days after the spray was applied. In seeking a further explanation for the quality of work during the different project periods, an analysis of Mr. Gibson's data indicates that there was a marked let-down in the quality of work as the operation progressed. Data from trees treated during the three project periods show the following percent of poorly treated trees:

Project period	May 7 - 19	May 20 - 31	June 1 - 12
Improperly treated trees	25.7%	30.8%	35.5%
Effectiveness of treatment	96.6%	90.5%	84.9%

Although the relationship between these two sets of figures is quite significant, other factors are involved which can not be disregarded. For example, not all trees containing living insects show improper treatment, and of course there is the green bark at the base of trees which invariably harbors live insects.

	Number	Percent
Trees treated	1,024	---
Trees examined	164	16.2 of trees treated
Trees examined showing complete control	82	50.0 of trees examined
Trees examined - living insects - no explanation	26	15.8 of trees examined
Trees examined - living insects - green bark	7	4.3 of trees examined
Trees examined - living insects - poor treatment	49	29.9 of trees examined

The above figures show that 49 of the trees examined were considered as having been improperly treated, and as suggested, it is also possible that "insufficient coverage" may explain the survival which occurred in the other 26 trees. If proper treatment had placed these trees in the complete control column, a much higher percent of mortality would have followed.

Table 3 - Grouping of treated trees as to the effectiveness of treatment

Crew	Total trees treated	Number of trees examined	Number of trees showing mortality: 100%	90-99%	75-89%	0-74%	Percent of treated trees with mortality above 90%
Robinett	60	10	30	30	---	---	100.0
Russell	19	10	11	8	---	---	100.0
Miller	156	22	56	86	0	14	91.2
Blanchard	111	23	68	29	9	5	87.0
Denker	75	12	13	44	12	6	76.0
Reese	125	16	47	47	8	23	75.0
McKenzie	103	15	41	34	21	7	73.0
Pegg	73	12	37	12	12	12	67.2
Francisco	59	11	16	21	11	11	63.0
Gumm	208	24	35	78	69	26	54.3
Kelly	20	9	2	2	7	9	20.0

About the only conclusion that can be drawn from the data in table 3 is an inconsistency of results obtained by different crews. Although improper treatment has been cited as an explanation for some of this variation in efficiency, other questions remain unanswered. However, if satisfactory results are obtained in a large percent of the treated trees, there must be some correctable factor responsible for the failure of others. Subsequent controlled experiments may answer this question, which is hoped will prove to be one of effective treatment.

Table 4 - Summary tabulation of crew production and effectiveness

Crew	Trees treated	Sq. ft. of bark per gallon of spray	Number of trees treated per man day	Percent of treated trees showing brood mortality above 90%	Average brood mortality obtained in treated trees
Russell	19	74	2.5	100 %	98.5%
Robinett	60	97	2.9	100	97.7
Blanchard	111	52	3.4	87.0	96.6
Miller	156	91	2.9	91.2	93.9
McKenzie	103	101	2.8	73.0	91.1
Decker	75	110	2.8	76.0	89.3
Francisco	59	81	2.5	63.0	85.5
Reese	125	106	2.9	75.0	85.4
Gumm	208	104	3.4	54.0	85.2
Pegg	73	87	3.1	67.2	84.8
Kelly	20	83	3.3	20.0	68.1

Here again the preceding summary tabulation (table 4) only illustrates the inconsistency of the results obtained by different crews. Obviously a relation would exist between the average mortality obtained and the percent of trees showing a plus 90% mortality, as both these figures are measurements of the same result. On the other hand, there is no correlation between output, area of bark surface treated per gallon of spray, and results. A comparison of the work of Robinett and Blanchard depicts this fact quite clearly. Blanchard used nearly twice as much spray and yet treated 1/2 of a tree more per man-day. However, it is apparent that he

used more spray than necessary, as the results obtained by these two crews are approximately the same. On the other hand, Gumm, Reese, Decker and McKenzie all covered more than 100 square feet of bark surface per gallon, with less effective results. From these figures it would seem that the original estimate of 80 square feet of bark surface per gallon of spray would when properly applied provide adequate coverage. The noneffectiveness of Kelly's work can be properly questioned, as it was during the last three days of the project and it is quite possible that final mortality had not occurred at the time of examination. Likewise the splendid results of Russell and Robinett were undoubtedly influenced by the fact that they did not treat any trees during the last project period.

In summarizing this discussion of factors contributing to the effectiveness of the spray, the only tangible evidence available points to the character of work performed as being the most important, and that adequate training and supervision is essential in reaching a desired degree of perfection.

SUMMARY COMMENTS

The following comments are drawn from information obtained during the project, as well as from the subsequent examination of the treated trees. Although these comments may repeat considerable information already given in this report, it is desired to include in this summary all suggestions which will be of value in planning future operations.

Supervision:

Penetrating sprays do not provide a fool-proof method of bark beetle control; in fact, more care must be exercised in their application than with other methods previously employed. To be effective a penetrating spray must be carefully applied, and any departure from an accepted standard of work will be reflected in the poor results obtained. If such departures are to be avoided, treating crews must be under constant and adequate supervision. Savings in supervision are lost in poor work which follows.

Training:

In the organisation of bark beetle control operations proper consideration must be given to the training of project personnel. Laborers should be trained by their foremen, who previously should have been given adequate instruction, through practical demonstrative methods, of their specific duties. No foremen should be permitted to train men until they have demonstrated their fitness for such duty. A poorly trained foreman becomes a project problem, requiring extra supervision, and one which is seldom cured.

As a supplement to the physical training of both spotters and treaters, a simple set of instructions giving details of task to be performed should be provided for each man. It is believed that crew leaders would profit from a discussion of the responsibilities of leadership and what is expected of them. There should be no let-down from an accepted standard of training, as time spent in training will be saved in subsequent supervision as well as in the effectiveness of results obtained.

Personnel:

When men are employed for projects of this character, consideration should be given to the different tasks, and men hired for specific jobs whenever possible. Employees should understand that although in the treating crew organization there will be certain assigned duties, each crew member will be expected to leave his assigned task whenever necessary to help in completing the job to be done. Treating crew foremen must conscientiously apply themselves to the execution of their assigned task, and it must be made clear to them that they are not bosses, but working foremen, who through their leadership will exact an efficient service from their organization. The application of a penetrating spray is not a difficult task, but it can not be applied in a slipshod, what-is-it-to-me manner if satisfactory returns are to follow.

Treating Crew Organization:

The 3-man treating crews were organized as being the most efficient self-operating unit. Although results seemed to support this belief, it is quite possible that the size of the treating organization can be improved upon. During the project extra men were added to certain crews, and although in some instances they increased the crew-day output, in all instances the man-day output was reduced. Regardless of this fact, this phase of future operations should receive careful consideration.

Treating Technique:

The method of applying these sprays was adopted as giving the best results with a minimum of material. Departures from this practice should not be accepted except when working under unusual conditions. The following points summarize the technique employed:

1. Spray should be applied to top arc of log only.

2. After each upper arc is treated, log is turned so as to expose another strip.

3. Treater, whenever possible, should walk along the log while treating.

4. There should be no missed or lightly treated areas between strip.

5. Brush should be removed from around the log so as to permit proper treatment, and layers of heavy moss or lichens should be removed from the bole.

6. Nozzle must be held at a distance from the log so as to cover the width of the arc to be sprayed, which should never be more than 1/4 of the circumference, and each log should be turned at least three times.

7. The distance that the nozzle is held from the bark governs the speed that the treater moves along the log, as the discharge from the nozzle is the same at all times.

8. Fan-shaped nozzle is designed to provide a thorough coverage with a once-over movement. This phase of the operation should be carefully developed so as to avoid a swishing of the nozzle back and forth in order to give some spot a bit more spray. Such treatment wastes spray, as portions of the logs are covered three times.

9. Crew foremen should be equipped with small hand axe to be used in determining the length of infestation.

10. Care should be used in determining the length of the log to be treated. Although it is obviously best to play safe in this connection, unnecessary treatment wastes time and materials.

Preparation of Spray Mixture:

The mixing of the ingredients used in the spray formula should be done at some central point, prior to transportation to the woods, which will need vary to meet the conditions of each project. The responsibility of mixing this spray should be given to a dependable employee, as proportions are easily confused, and such mistakes could prove costly to the project.

Transportation of Spray:

The adoption of transportation facilities to provide the treating crews with an adequate supply of spray is an important and difficult task. If this supply is not maintained, production will either be reduced or trees will be improperly treated, as crews will not return to camp in the late afternoon to replenish their supply.

During the Coeur d'Alene project one pack animal carrying 20 gallons of spray was assigned to each crew. To augment this service it was planned to establish spray caches at different points in the field, from which an additional supply could be obtained when necessary. This plan did not work overly well, as the caches were difficult to find and with one man absent from the crew, production nearly stopped. To meet this requirement of an adequate supply of spray, which is essential to a maximum and effective crew production, it is suggested that a service-of-supply pack string be added to the organization used on the Coeur d'Alene project. The function of this pack string would be to contact all crews during the day, with the idea of adding to the 20 gallons carried by the assigned pack animal sufficient spray to last

throughout the day. It is believed that this additional expense will be more than offset by an increased production and a more thorough treatment of all trees.

Equipment:

The spray tanks used on this project were quite satisfactory. To replace the hose with which the spray tanks are equipped, a supply of oil-resistant hose (Mainstay) was obtained from the D.B.Smith Company, Utica, New York. Extra washers and tank gaskets made from "Thiokol", an oil-resistant substance, were also obtained from the same company. It is also advisable to have extra pump and shut-off parts. An extra spray tank or two at each camp will prove of value while out-of-order tanks are being repaired.

Although they were not used on the Coeur d'Alene project, an extension strainer "Tornado" (D.B. Smith Co.) should be a standard part of each spray tank. This strainer does not interfere with the action of the equipment and will eliminate nozzle plugging from foreign substances which invariably get into the spray.

The nozzle designed at this laboratory to produce a desired fan-shaped spray gave satisfaction, although additional work is needed to make it more durable and less liable to maladjustments.

In using the 5-gallon cans the light retaining ring should always be used over the caps. Without these rings the caps can be knocked loose by limbs or other objects.

As it was found that the specially constructed pack boxes gave better service when packed vertically rather than horizontally, they should be constructed with necessary straps for fastening to Decker saddles.

On the Coeur d'Alene project, after the mixed spray was transported from the end of the truck road to the camp in 5-gallon containers, it was stored in 50-gallon drums. This was considered advisable because of expense of purchasing additional 5-gallon containers. Although it is believed that surplus stock as well as some emergency caches of spray could be effectively stored in 50-gallon drums, considerable effort would be saved on the part of the packers if sufficient cans were provided to permit the full cans to be substituted for empties. This arrangement would not be necessary if the camp was located on a truck road.

CONCLUSIONS

The results obtained from this experimental control operation were not as satisfactory perhaps as had been hoped for. However, in view of such conditions as unfavorable weather, labor shortage, and inexperience in the execution of this method of treatment, all of which were peculiar to this project, it would seem that the results were as satisfactory as could be expected, both from a standpoint of cost as well as effectiveness. It is believed that with future projects conducted during more favorable conditions, many of the apparent weaknesses of this operation can be corrected.

It can be said that this project successfully demonstrated the practicability of using penetrating sprays as a method of control for the mountain pine beetle in white pine. As practibility depends primarily upon the expense of treatment, it is believed that the cost per tree as shown for this project can be reduced in future operations.

Possibly a smaller proportion of orthodichlorobenzene will prove effective, which will reduce the cost of the mixed spray. With more experience and under more favorable working conditions, crew production can be increased while still maintaining a satisfactory standard of treatment. There will no doubt be other improvements which can be instituted in future operations.

Perhaps the most difficult problem to be solved in connection with the use of penetrating sprays is the selection of capable, conscientious crew foremen, and their training and supervision. To obtain the proper treatment of all trees through supervision alone is quite difficult, if not impossible. This objective must be met through proper training of personnel and the building of a desire on the part of the crew foremen to perform an efficient service. These two important factors must of course be supplemented with adequate supervision, not for the correction of careless or improper work, which should not exist, but for the purpose of helping the crew foremen in the solution of their problems, and above all to maintain on the part of each crew the desire to perform an efficient and effective service. Although future operations must still be regarded as somewhat experimental, it is sincerely believed that penetrating sprays can be used as a method of control for the mountain pine beetle in white pine.

Infested tree being felled for treatment

Specially constructed pack boxes containing 5-gallon cans of spray

Difficult treatment due to heavy underbrush

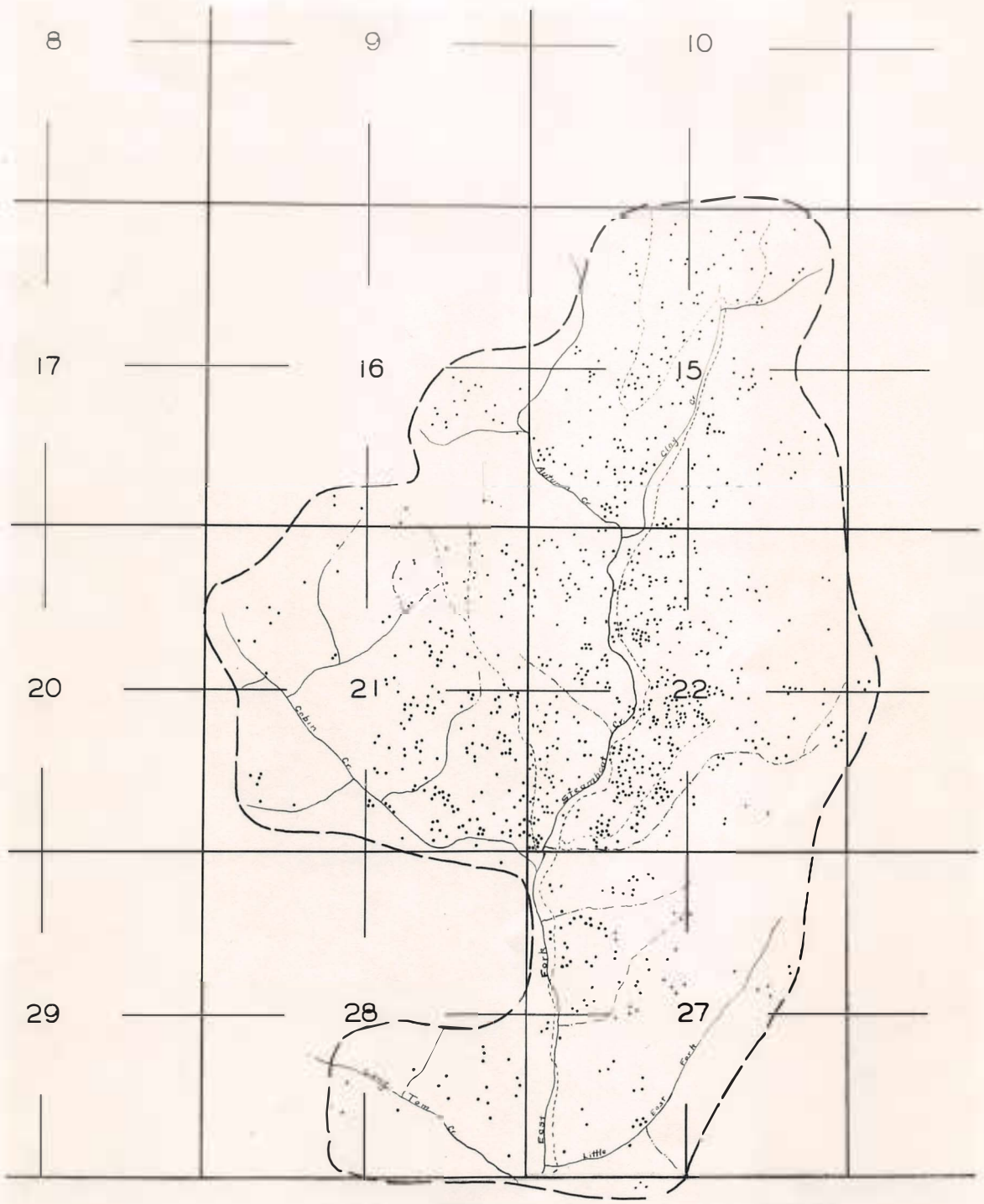
Absence of underbrush provides for easy treatment

Special nozzle showing
desired fan-shaped spray

Turning log to permit
spraying along upper side

Nozzle held too far from log.
Spray wasted on right side
of treater.

Proper method of treatment.
Nozzle held so that there
is no waste.



STEAMBOAT INSECT CONTROL AREA
Spring of 1941

Each dot represents a treated tree